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Remarks:

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(54) **Catalyst for producing phthalic anhydride**

(57) A catalyst excelling in catalytic properties and allowing phthalic anhydride to be produced stably in a high yield for a long time, a method of preparation suitable for the preparation of the catalyst, and a method for the production of phthalic anhydride by the use of the catalyst are disclosed. A catalyst for catalytic gas phase production of phthalic anhydride having a catalytically active component supported on a carrier such that water, after undergoing the treatment described below, exhibits specific resistance exceeding a prescribed mag-

nitude, a method for the preparation of the catalyst, and a method for the production of phthalic anhydride by the use of the catalyst.

(Treatment) In a conical beaker having an inner volume of 500 ml, 300 ml of a given carrier is placed and dried at 120°C for two hours and then the dried carrier and (amount of water absorption + 220) ml of purified water added thereto are heated together under normal pressure at 90°C for 30 minutes.

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Description

BACKGROUND OF THE INVENTION

Field of the Invention:

[0001] This invention relates to a catalyst for the gas phase partial oxidation of orthoxylene and/or naphthalene, a method for the preparation thereof, and a method for producing phthalic anhydride using the catalyst.

Description of the Related Art:

[0002] The gas phase partial oxidation of aromatic compounds or alkyl-substituted heterocyclic compounds are practiced widely on a commercial scale, such as the production of phthalic anhydride by the gas phase partial oxidation of orthoxylene and/or naphthalene, the production of maleic anhydride by the gas phase partial oxidation of benzene, the production of pyromellitic anhydride by the gas phase partial oxidation of 1,2,4, 5-tetraalkyl benzene, and the production of an aromatic nitrile or a heterocyclic nitrile by the ammoxidation of an alkyl-substituted aromatic compound or an alkyl-substituted heterocyclic compound. Various catalysts have been proposed for use in the gas phase partial oxidation.

[0003] These gas phase partial oxidation catalysts have excellent properties of themselves. Nevertheless, the development of gas phase catalysts excelling in catalytic qualities such as activity, selectivity, and service life constitutes a constant theme for researchers in the relevant technical field.

SUMMARY OF THE INVENTION

[0004] An object of this invention is to provide a catalyst for the gas phase partial oxidation of orthoxylene and/or naphthalene which excels in catalytic qualities and enables phthalic anhydride to be obtained stably in a high yield for a long time.

[0005] Another object of this invention is to provide a method of preparation suitable for the preparation of the catalyst.

[0006] Yet another object of this invention is to provide a method for the gas phase partial oxidation of orthoxylene and/or naphthalen to produce phthalic anhydride by the use of the catalyst.

[0007] According to the first embodiment of this invention, it provides a catalyst for the gas phase partial oxidation of orthoxylene and/or naphthalen to produce phthalic anhydride which comprising a catalytically active component supported on an inert carrier, the carrier fulfilling the conditions that the water after the following treatment exhibits specific resistance of not less than 20, 000 $\Omega \cdot \text{cm}$ (25°C) in the case of producing phthalic anhydride:

(method of treatment)

[0008] In a conical beaker having an inner volume of 500 ml, 300 ml of a given carrier is placed and dried at 120°C for two hours and then the dried carrier and (amount of water absorption + 220) ml of purified water added thereto are heated at 90°C under normal pressure for 30 minutes, wherein the amount of water absorption is represented as follows:

$$\text{Amount of water absorption} = A/B$$

wherein $A = 300 \text{ (ml)} \times \text{packing density (g/ml)} \times \text{water absorption ratio (wt. \%)/100}$ and $B = \text{density of water (g/ml)}$.

[0009] According to the second embodiment of this invention, it provides a method for the production of phthalic anhydride which comprises effecting gas phase partial oxidation of orthoxylene and/or naphthalen with a molecular oxygen or a molecular oxygen-containing gas in the presence of the catalyst mentioned above.

[0010] Further, according to the third embodiment of this invention, it provides a method for the preparation of a catalyst for the gas phase partial oxidation of orthoxylene and/or naphthalen to produce phthalic anhydride, which comprises supporting a catalytically active component on an inert carrier, the fulfilling the conditions that the water after the following treatment exhibits specific resistance of not less than 20, 000 $\Omega \cdot \text{cm}$ (25°C) in the case of producing phthalic anhydride:

(method of treatment)

[0011] In a conical beaker having an inner volume of 500 ml, 300 ml of a given carrier is placed and dried at 120°C for two hours and then the dried carrier and (amount of water absorption + 220) ml of purified water added thereto are

heated at 90°C under normal pressure for 30 minutes, wherein the amount of water absorption is represented as follows:

$$\text{Amount of water absorption} = A/B$$

wherein $A = 300 \text{ (ml)} \times \text{packing density (g/ml)} \times \text{water absorption ratio (wt. \%)/100}$ and $B = \text{density of water (g/ml)}$.

[0012] The catalyst for the production of phthalic anhydride according to this invention excels in activity, selectivity, and service life and enables the phthalic anhydride to be produced in a high yield for a long time.

[0013] The above and other objects, features, and advantages of the present invention will become clear from the following description of the preferred embodiments.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0014] The treatment to be used in this invention prior to the determination of the specific resistance of water is performed by the following method: In a conical beaker having an inner volume of 500 ml (based on Japanese Industrial Standard (JIS) R-3503), 300 ml of a given carrier is placed and dried at 120°C for two hours and then the dried carrier and (amount of water absorption + 220) ml of purified water added thereto are heated at 90°C under normal pressure for 30 minutes, wherein the amount of water absorption is represented as follows:

$$\text{Amount of water absorption} = A/B$$

wherein $A = 300 \text{ (ml)} \times \text{packing density (g/ml)} \times \text{water absorption ratio (wt. \%)/100}$ and $B = \text{density of water (g/ml)}$.

[0015] The term "packing density (D)" used in the preceding formula means the magnitude which is represented by the formula, $D = W1 \text{ (g)} / 1000 \text{ ml}$ (wherein W1 denotes the weight of the carrier which fills a measuring cylinder, 65 mm in inside diameter 1000 ml in inner volume, when the dried carrier is fed into the measuring cylinder at a rate of 2000 ml/minute).

[0016] The term "water absorption ratio (M)" used therein means the magnitude which is represented by the formula, $M = [(W3 \text{ (g)} - W2 \text{ (g)}) / W2 \text{ (g)}]$ (wherein W2 denotes the weight of 300 ml of the dried carrier and W3 denotes the weight found after 300 ml of the dried carrier is placed in a basket made of stainless steel wire, heated in boiling purified water for 30 minutes, then removed from the basket, wiped with a wet gauze till removal of excess water, and weighed).

[0017] This invention concerns a catalyst for the gas phase partial oxidation of orthoxylene and/or naphthalen having a catalytically active component supported on an inert carrier, characterized by the carrier used therefore causing the water after undergoing the treatment mentioned above to exhibit specific resistance of not less than $20,000 \Omega \cdot \text{cm}$ (25°C).

[0018] This invention concerns a catalyst suitable for the production of phthalic anhydride from orthoxylene and/or naphthalen, a method for the preparation thereof, and a method for the gas phase partial oxidation of orthoxylene and/or naphthalen to produce phthalic anhydride by the use of the catalyst.

[0019] The inert carrier to be used in this invention does not need to discriminate the material itself to be used therefor. It may be any of the carriers which are popularly used and are known to be used in preparing catalysts for the production of phthalic anhydride by the gas phase partial oxidation of orthoxylene and/or naphthalene. As examples of the material which is popularly used for the carrier of catalyst, it may be cited, for example, alumina, silica, silica-alumina, titania, magnesia, silica-magnesia, silica-magnesia-alumina, silicon carbide, silicon nitride, and zeolite.

[0020] For example, JP-A-57-105,241 discloses a self-sintered silicon carbide being used as the carrier for a catalyst for the production of phthalic anhydride from orthoxylene and/or naphthalene.

[0021] The inert carrier which is the self-sintered silicon carbide mentioned above and the inert carrier having silicon carbide as a main component thereof are used advantageously in this invention. In these inert carriers, the latter carrier is particularly advantageously used because it is inexpensive, exhibits excellent thermal conductivity based on silicon carbide, and is easily molded in a required shape.

[0022] The expression "inert carrier having silicon carbide as a main component thereof" herein means a carrier of the type obtained by using silicon carbide as a main component, mixing it with an inorganic binding agent, and sintering the resultant mixture in the required shape. The silicon carbide content of the carrier is preferred to be not less than 70 wt. %. As an example of the carrier having silicon carbide as a main component thereof, it may be cited the inert carrier which, as disclosed in JP-A-09-85,096, has a silicon carbide content of not less than 70 wt. % and contains silicon dioxide and mullite as the inorganic binding agents.

[0023] Besides, an inert carrier that has steatite as a main component thereof is advantageously used in this invention.

[0024] As for the carrier to be used in this invention, physical properties, shape or size is not limited. As concerns

physical properties, the specific surface area thereof may be not more than $0.3 \text{ m}^2/\text{g}$ and preferably in the range of $0.02 - 0.2 \text{ m}^2/\text{g}$ and the porosity thereof may be in the range of $0 - 35\%$, preferably $16 - 30\%$. The shape may be freely selected from among sphere, cylinder, hollow cylinder etc. As regards the size, the average particle diameter may be in the approximate range of $2 - 15 \text{ mm}$, preferably in the approximate range of $3 - 12 \text{ mm}$, in the case of spheres.

[0025] This invention is characterized by the carrier used therein causing the water after undergoing the treatment mentioned above to exhibit specific resistance of not less than $20,000 \Omega \cdot \text{cm}$ (25°). To be specific, the carrier to be used is such that when 300 ml of the carrier is placed in a conical beaker having an inner volume of 500 ml and dried at 120°C for two hours, and then the dried carrier and (amount of water absorption + 220) ml of purified water added thereto are heated at 90°C under normal pressure for 30 minutes, the water subsequently to this treatment exhibits specific resistance not less than $2 \times 10^4 \Omega \cdot \text{cm}$ (25°C), preferably falling in the range of $25,000 - 1 \times 10^6 \Omega \cdot \text{cm}$ (25°C), and particularly preferably falling in the range of $3 \times 10^4 - 1 \times 10^6 \Omega \cdot \text{cm}$ ($^\circ\text{C}$).

[0026] The term "specific resistance" herein refers to the magnitude which is the reciprocal of the conductivity of water determined after the treatment mentioned above at 25°C with a conductivity meter. In this invention, when the specific resistance is $20,000 \Omega \cdot \text{cm}$, for example, it is expressed as $20,000 \Omega \cdot \text{cm}$ (25°C).

[0027] The carrier which exhibits the specific resistance of not less than $20,000 \Omega \cdot \text{cm}$ (25°C) for the water after the treatment mentioned above can be advantageously prepared by washing a given carrier with water, preferably purified water, to a certain level.

[0028] One concrete method for effecting this washing consists in that the specific resistance for the water after the treatment mentioned above exceeds $2 \times 10^4 \Omega \cdot \text{cm}$ (25°C), preferably falls in the range of $25,000$ to $1 \times 10^6 \Omega \cdot \text{cm}$ (25°C), and more preferably $30,000 - 1 \times 10^6 \Omega \cdot \text{cm}$ (25°C), for example by repeating an operation of heating a carrier under normal pressure at 90°C for 30 minutes. This operation does not need to be repeated when the first round of the operation allows the specific resistance for the water after the treatment mentioned above reaches a level exceeding $20,000 \Omega \cdot \text{cm}$ (25°C). When this operation is performed up to a plurality of repetitions, each operation must use newly supplied water and require this water to be tested for specific resistance subsequently to the treatment mentioned above. The amount of water to be used for the washing does not need to be particularly limited. When the carrier has a volume of 300 ml , for example, the amount of water to be used is the sum of amount of water absorption + 220 ml in the first round of the operation and 220 ml each in the second and subsequent rounds.

[0029] Prior to the washing with water described above, the carrier may be washed with an acidic aqueous solution such as of nitric acid, a basic aqueous solution such as of ammonia water, or an organic solvent such as an alcohol. When an aqueous nitric acid solution, for example, is used for this preparatory washing, it is commendable to repeat an operation of heating the carrier under normal pressure at 90°C . In this case, a carrier which has undergone this operation must be washed with water. During this washing with water, however, the carrier is not always required to be heated under normal pressure at 90°C .

[0030] The means suitable for washing the carrier are not particularly restricted. The carrier may be washed by being heated in conjunction with a washing liquid or by being exposed to a reduced pressure or increased pressure.

[0031] The catalyst of excellent catalytic properties for the gas phase partial oxidation of orthoxylene and/or naphthalene can be obtained by washing the carrier preferably with water as described above or using the carrier exhibiting the specific resistance of not less than $20,000 \Omega \cdot \text{cm}$ (25°C) for the water after the treatment mentioned above.

[0032] The catalyst of this invention for the gas phase partial oxidation of orthoxylene and/or naphthalene can be prepared in accordance with the method known to the art except that the inert carrier mentioned above is used therefore.

<1> Production of phthalic anhydride from orthoxylene and/or naphthalene

[0033] Generally, it is used a catalyst in which a catalytically active component containing the oxides of (1) vanadium and (2) titanium is supported on the inert carrier mentioned above.

[0034] Particularly, catalysts suitable therefore are obtained by preparing an oxide composition containing (1) vanadium, (2) titanium, and (3) at least one element selected from the group consisting of alkali metal elements, rare earth elements, sulfur, phosphorus, antimony, niobium, and boron as a catalytically active component and supporting this oxide composition on the inert carrier mentioned above.

[0035] Methods suitable for supporting the catalytically active substance on the inert carrier are not particularly restricted. It may be cited a method which comprises placing a prescribed amount of the inert carrier in a rotary drum capable of being externally heated and keeping the inert carrier at $200 - 300^\circ\text{C}$ and meanwhile spraying thereon a liquid (slurry) containing the catalytically active substance thereby supporting the active substance on the carrier. In this case, the amount of the active substance to be supported on the inert carrier depends on the size and the shape thereof. When the inert carrier is in the shape of spheres or cylinders, this amount may be proper in the range of $3 - 30 \text{ g}$, particularly $5 - 20 \text{ g}$ of active substance/ 100 ml of inert carrier.

[0036] The reaction of gas phase partial oxidation contemplated by this invention can be effected in accordance with any of the methods popularly practiced in executing various reactions except that the catalyst for gas phase partial

oxidation described above is adopted. Generally, it is carried out with a reaction tube made of carbon steel or stainless steel and loaded with the catalyst for gas phase partial oxidation of this invention. The reaction tube is preferred to keep at a constant temperature by means of a thermal medium such as molten salt so that the reaction temperature may be adjusted at a constant level by the removal of the heat of reaction. Conditions suitable for the reaction of gas phase partial oxidation are not particularly restricted. The reaction can be carried out under any of the conditions popularly adopted for varying reactions. In the case of the reaction <1> mentioned above, for example, it may bring the orthoxylene-containing gas into contact with the partial oxidation catalyst at a temperature in the range of 300 - 400°C, preferably 330 - 380°C, under normal pressure or by application of pressure.

EXAMPLE

[0037] Now, this invention will be described more specifically below with reference to examples. The conductivity was measured with a conductivity meter (available from Horiba K.K. in Japan as a type of "DS-12").

Example 1

Washing of carrier (1)

[0038] Three liters of hollow cylinder of carrier (1) were heated in three liters of purified water at 90°C for 30 minutes to wash, the carrier (1) consisting of silicon carbide, silicon dioxide, and mullite at a weight percentage of 90 : 5 : 5, containing an alkali metal element and an alkaline earth metal element in a total of 0.2 wt. % (hereinafter referred to as "alkali content"), and exhibiting a packing density of 0.88 g/ml, a water absorption ratio of 15%, a specific surface area of 0.14 m²/g, and a porosity of 23%, each hollow cylinder measuring 6.9 mm in outside diameter, 3.7 mm in inside diameter, and 7.3 mm in length. The washed carrier is labeled as (1W).

[0039] In a conical beaker, 500 ml in inner volume (based on JIS R-3503), 300 ml of the carrier (1W) was dried at 120°C for two hours and then the dried carrier and 260 ml [= (300 x 0.88 x 0.15) + 220] of purified water added thereto were heated together under normal pressure at 90°C for 30 minutes. After treatment, the water was separated from the beaker and tested for conductivity. As a result, the water had a specific resistance of 27,400 Ω · cm (25°C).

Preparation of catalyst

[0040] Ilmenite was mixed with 80% concentrated sulfuric acid, the mixture was allowed to react thoroughly and then diluted with water to give an aqueous solution containing titanium sulfate. The resultant aqueous solution was added with an iron piece as a reducing agent, heated in order to reduce the iron component in the ilmenite into ferrous ions and cooled to induce precipitation and separation of ferrous sulfate. To the resultant aqueous titanium sulfate solution, steam heated to 150°C was brown to induce sedimentation of hydrated titanium oxide. This sediment was washed with water, washed with acid, given a secondary washing with water, and then calcined at a temperature of 800°C under a stream of air for four hours. The calcined product was pulverized with a jet stream of air to obtain anatase titanium dioxide having an average particle diameter of 0.5 μm and a specific surface area of 22 m²/g.

[0041] Separately, an aqueous oxalic acid solution was obtained by dissolving 100 g of oxalic acid into 3200 ml of deionized water. In the aqueous solution, 23.63 g of ammonium metavanadate, 2.99 g of ammonium dihydrogen phosphate, 9.40 g of niobium chloride, 4.13 g of cerium sulfate, and 18.35 g of antimony trioxide were placed and thoroughly stirred. The solution thus obtained and 900 g of the aforementioned anatase titanium dioxide added thereto were stirred together with an emulsifying machine to prepare a catalyst slurry.

[0042] In a stainless steel rotary kiln measuring 35 cm in diameter and 80 cm in length and adapted to be externally heated, 1000 ml of the carrier (1W) was placed and preheated to 200 - 250°C and, with the kiln kept in rotation, the aforementioned catalyst slurry was sprayed onto the preheated carrier to support the catalytically active substance at a ratio of 9.5 g/100 ml of the carrier. The resultant composite was calcined under a stream of air at 580°C for 6 hours to prepare a catalyst (A).

[0043] The procedure for the preparation of catalyst (A) was repeated except that the amount of ammonium dihydrogen phosphate was changed to 11.96g to prepare a catalyst (B).

[0044] The catalyst compositions of catalyst (A) and catalyst (B) are shown in Table 1 below.

Partial oxidation

[0045] In a carbon steel reaction tube, 25 mm in inside diameter and 3 m in length, immersed in a molten salt bath retained at a temperature of 350°C, firstly catalyst (B) was loaded to a height of 1 m in the feed gas outlet part as a second-stage catalyst and then catalyst (A) was piled on the loaded catalyst (B) to a height of 1.8 m in the inlet part

as first-stage catalyst.

[0046] A feed gas obtained by mixing orthoxylene and air at a ratio of 70 g/Nm³ (air) was introduced into the reactor through the upper inlet at a space velocity (SV) of 2910 Hr⁻¹ (STP: Standard Temperature and Pressure) to effect partial oxidation of orthoxylene. The yield of phthalic anhydride and the amount of phthalide (by-product) were measured during the initial stage of reaction and three months after the start of the reaction.

[0047] The results are shown in Table 2 below. The conversion of orthoxylene was nearly 100%, a fact which implies that the yield mentioned above could be regarded as the selectivity of phthalic anhydride.

Example 2

[0048] The procedure of Example 1 (preparation of catalyst) was repeated except that a carrier (2W) was used instead of carrier (1W) to prepare catalysts (C) and (D) respectively.

[0049] The procedure of Example 1 (Partial oxidation) was repeated except that catalysts (C) and (D) were used instead of catalysts (A) and (B).

[0050] The compositions of catalysts (C) and (D) are shown in Table 1 below and the results of the reaction of partial oxidation are shown in Table 2 below.

Washing of carrier (2)

[0051] Three liters of hollow cylinder of steatite carrier (2) were heated in 3 liters of purified water at 90°C for 30 minutes, the steatite carrier (2) exhibiting a loaded density of 1.08 g/ml, a water absorption ratio of 3%, a specific surface area of 0.007 m²/g, and a porosity of 5%, each hollow cylinder measuring 6.9 mm in outside diameter, 3.8 mm in inside diameter, and 7.0 mm in length. The washed carrier was labeled as (2W).

[0052] In a conical beaker, 500 ml in inner volume, 300 ml of the carrier (2W) was dried at 120°C for two hours and then the dried carrier and 230 ml [= (300 × 1.08 × 0.03) + 220] of purified water added thereto were heated together under normal pressure at 90°C for 30 minutes. After treatment, the water was separated from the beaker and tested for conductivity. As a result, the water had a specific resistance of 44,200 Ω · cm (25°C).

Comparative Example 1

[0053] The procedure of Example 1 (preparation of catalyst) was repeated except that the raw carrier (1) not washed as indicated in Example 1 was used instead of carrier (1W) to prepare catalysts (E) and (F) respectively.

[0054] The procedure of Example 1 (Partial oxidation) was repeated except that catalysts (E) and (F) were used instead of catalysts (A) and (B).

[0055] The compositions of catalysts (E) and (F) are shown in Table 1 below and the results of the reaction of partial oxidation are shown in Table 2 below.

[0056] In a conical beaker, 500 ml in inner volume, 300 ml of the carrier (1) was dried at 120°C for two hours and the dried carrier and 260 ml [= (300 × 0.88 × 0.15) + 220] of purified water added thereto were heated together under normal pressure at 90°C for 30 minutes. After treatment, the water was separated from the beaker and tested for conductivity. As a result, the water had a specific resistance of 10,500 Ω · cm (25°C).

Comparative Example 2

[0057] The procedure of Example 2 (preparation of catalyst) was repeated except that the raw carrier (2) not washed as indicated in Example 2 was used instead of carrier (2W) to prepare catalysts (G) and (H) respectively.

[0058] The procedure of Example 2 (Partial oxidation) was repeated except that catalysts (G) and (H) were used instead of catalysts (C) and (D).

[0059] The compositions of catalysts (G) and (H) are shown in Table 1 below and the results of the reaction of partial oxidation are shown in Table 2 below.

[0060] In a conical beaker, 500 ml in inner volume, 300 ml of the carrier (2) was dried at 120°C for two hours and the dried carrier and 230 ml [= (300 × 1.08 × 0.03) + 220] of purified water added thereto were heated together under normal pressure at 90°C for 30 minutes. After treatment, the water was separated from the beaker and tested for conductivity. As a result, the water had a specific resistance of 9,500 Ω · cm (25°C).

TABLE 1

Example	Carrier		Catalyst	Catalyst bed	Composition of catalyst active component (wt.ratio)					
	Name	SRW			V ₂ O ₅	TiO ₂	Nb ₂ O ₅	P ₂ O ₅	Cs ₂ O	Sb ₂ O ₃
1	1W	27,400	A	First	2	98	0.5	0.2	0.35	2.0
	1W	27,400	B	Second	2	98	0.5	0.8	0.35	2.0
2	2W	44,200	C	First	2	98	0.5	0.2	0.35	2.0
	2W	44,200	D	Second	2	98	0.5	0.8	0.35	2.0
C. Ex 1	1	10,500	E	First	2	98	0.5	0.2	0.35	2.0
	1	10,500	F	Second	2	98	0.5	0.8	0.35	2.0
C. Ex 2	2	9,500	G	First	2	98	0.5	0.2	0.35	2.0
	2	9,500	H	Second	2	98	0.5	0.8	0.35	2.0

SRW: Specific resistance of water; C. Ex.: Comparative Example

TABLE 2

Example	Initial stage of reaction			After three months		
	RT (°C)	YPA (wt%)	YP (mol%)	RT (°C)	YPA (wt%)	YP (mol%)
1	350	112.3	0.08	350	112.6	0.06
2	354	111.6	0.08	354	111.7	0.07
C.Ex.1	353	110.5	0.08	353	109.5	0.20
C.Ex.2	355	110.1	0.08	355	109.4	0.12

RT: Reaction temperature; YPA: Yield of phthalic anhydride; YP: Yield of phthalide

Claims

1. A catalyst for producing phthalic anhydride by means of gas phase partial oxidation from orthoxylene and/or naphthalene, comprising an inert carrier and a catalytically active component supported thereon, **characterized by** the carrier fulfilling the condition that:

the water after being used in the following treatment exhibits specific resistance of not less than 20,000 $\Omega \cdot \text{cm}$ (25°C);

treatment: in a conical beaker having an inner volume of 500 ml, 300 ml of a given carrier is placed and dried at 120°C for two hours and then the dried carrier and (amount of water absorption + 220) ml of purified water added thereto are heated together under normal pressure at 90°C for 30 minutes, wherein the amount of water absorption is represented by:

$$\text{Amount of absorption} = A/B$$

wherein $A = 300 \text{ (ml)} \times \text{packing density (g/ml)} \times \text{water absorption ratio (\% by weight)}/100$ and $B = \text{density of water (g/ml)}$.

2. A catalyst according to claim 1, wherein the carrier contains silicon carbide, silica-alumina, or steatite.
3. A catalyst according to claim 1, wherein the catalytically active component contains the oxides of vanadium and titanium.
4. A method for the production of phthalic anhydride, **characterized by** effecting gas phase partial oxidation of orthoxylene and/or naphthalene with molecular oxygen or a molecular oxygen-containing gas in the presence of a catalyst set forth in claim 1.
5. A method for preparing a catalyst having a catalytically active component supported on an inert carrier and serving the purpose of effecting gas phase partial oxidation of orthoxylene and/or naphthalene to produce phthalic anhydride, **characterized by** the carrier fulfilling the condition that:

the water after being used in the following treatment exhibits specific resistance of not less than 20,000 $\Omega \cdot \text{cm}$ (25°C);

treatment: in a conical beaker having an inner volume of 500 ml, 300 ml of a given carrier is placed and dried at 120°C for two hours and then the dried carrier and (amount of water absorption + 220) ml of purified water added thereto are heated together under normal pressure at 90°C for 30 minutes, wherein the amount of water absorption is represented as follows:

$$\text{Amount of water absorption} = A/B$$

wherein $A = 300 \text{ (ml)} \times \text{packing density (g/ml)} \times \text{water absorption ratio (\% by weight)}/100$ and $B = \text{density of water (g/ml)}$.



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 01 5295

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	DE 22 35 103 A (HUELS CHEMISCHE WERKE AG) 7 February 1974 (1974-02-07) * the whole document *	1, 3, 5	B01J23/22 B01J35/00 C07C51/265 C07C51/31
D, X	PATENT ABSTRACTS OF JAPAN vol. 0061, no. 91 (C-127), 30 September 1982 (1982-09-30) & JP 57 105241 A (NIPPON SHOKUBAI KAGAKU KOGYO CO LTD), 30 June 1982 (1982-06-30) * abstract *	1-4	
X	US 3 926 846 A (NAKANISHI YOSHIYUKI ET AL) 16 December 1975 (1975-12-16) * claims 1, 3, 5, 7 * * column 4, line 14 - line 62 * * examples *	1-5	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B01J C07C C07D
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		12 August 2004	Zuurdeeg, B
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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